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WALKS UNDER THE SEA BY A CORAL STRAND.

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I VIVIDLY recall a scene which suddenly presented itself upon entering one of the broad bights which indent the eastern shore of Andros Island, Bahama. Once within the reef, which here leaves a wide channel between it and the shore, the prospect immediately changed like the shifting of scenery. We now sailed in a transparent, almost colorless medium, which stretched far away on every side. The sea just left behind seemed to rise up and enclose this water-island with a black, impenetrable wall, so great was the change in depth, and so intense was the light reflected from the mirror of coral sand on all the submerged reefs and banks. Ever and anon this dark ocean-line was broken into bars of silver—the glistening foam of breakers, which betray unseen and treacherous rocks. These radiant fields were pied with dark patches of sea-weed, and dappled with sombre masses of coral and sponge. By this celestial gate one imagines himself to be entering a city, the tops of cocoa-palms and other trees which alone are visible on yonder shores, answering to the spires and masts of some inland port.

The scale of colour ever changes with the altitude of the sun, with the character of the sea-bottom, and with the clouds, now flashing green fire on the horizon, and reflecting many intermediate tints between it and the crystal water at our feet. The

storm-clouds rising fast, and blackening all the sky, are thus doubly felt by their effects on the sea, which transmits the deepest shades that are possible in the ultramarine. Their high colour effects are due not only to the clarity of the sea, but also to those white calcareous particles, the coral sands, which the ceaseless grinding of the breakers on the reef is ever producing and ever sifting far and near over the wide sea floor. The sands which fill every lagoon and bay, are tossed up in long dazzling lines of smooth beach, and in course of time may become hardened into coral limestone like that out of which these islands are formed. The depth of coral waters is singularly deceptive, owing to the light reflected from the bottom, and there results that wonderful distinctness with which a varied host of living forms like the coral, the starfish and the sponge, can be clearly seen even at great depths. The remorseless green of the sturdy tropical bush which covers all the shores, and which knows no change of seasons, is thus relieved by a wide sea-girdle of ever varying tints.

The Bahama Islands are all coralline; that is they are due (primarily) to the life and growth of coral polyps, insignificant animals when contemplated singly, but able to girdle the globe, only give them time and the right conditions.

New Providence, where I spent several months in the study of marine life, is the geographical as well as the commercial and political centre of the group. It is a small, compact island, 17 miles long east by west, and 7 in greatest breadth. Its southerly half is cut by the 25th parallel of latitude, and the longitude of its capital, Nassau, is 77° 22′ W., which is a little west of Washington. While it is just without the tropic line, it is nevertheless considerably within the northern borders of tropical life.

The Bahama Islands, though widely separated, are yet remarkably alike in their animal and plant life, and this simularity, which is doubtless shared by all coral rocks and isles in West Indian seas, is due to like physical conditions. All of them are essentially rocks formed by the hardening of coral sands, usually low and flat, but sometimes rising into undulating hills, or making precipitous bluffs and shelving cliffs.

A slight eminence commands a wide prospect on a coral island, and I was particularly impressed with this fact one June day upon climbing the slope of a ridge which skirts the north-easterly shore of New Providence. Leaving the clean coral street at Dix Point, where an old gate guards the entrance to a disused lane, and where the crumbling walls of a cottage on the hillside above bear witness to better days, a momentary scramble through the thick bush brings you to the top. Far along the shore winds the emerald bay, hemmed in by long narrow islands, which, as we glance down the reef, gradually fade into the blue of the sky and of the sea. On the other hand lies New Providence, a vast mosaic in greens, the darker settings of the pine and of the palm mingling with the light new growth of this ever-springing vegetation. This wilderness of color, this green mantle of perpetual spring, is thrown into long folds, some eight of which I can count at this height, all of them running nearly parallel with the ridge on which we stand. They resemble lines of sand dunes, now hardened into stone and clad with vegetation, as possibly they are, such as may be seen on some of the island reefs, over which the ocean occasionally breaks in violent storms.

Much as these coral islands may interest us from their animal and plant life, which has also a story to tell, yet those *gardens under the sea*, the living coral reefs, to which these green specks at the surface owe their origin, introduce us to an entirely new world, to a fairy-land of strange forms and bright hues, far more populous and varied than that which fired the enthusiasm of its first discoverer.

Dix Point, of which I speak now more particularly, since it is an admirable specimen of a living, growing reef, forms the southern arm of a small winding bay not far from the north-eastern extremity of New Providence. The point is a low spit of land, or more specifically *rock*, covered with a growth of tropical bush, in which we notice the mangrove, the stilt-walker of the tropical swamp, the fragrant flowered logwood, the hoary conocarpus, and the round-leaved sea grape (*Coccoloba*). Some stone ruins on the eastern side, gray with age and half concealed by the encroaching bush, mark the abode of former and long forgotten

residents. Here as elsewhere the tide touches the threshold of vegetation, and with the ebb the exposed shallows make a wide beach-way, and the eroded rocks of the point are laid bare. The latter represent *hard-pan*, the stone foundation of the islands, which are capped with at most a very thin and discontinuous layer of soil. The extension of this Point under the sea is the reef which we are going to explore.

Nassau Bay is here less than a mile wide, and presents in strong lights a clear green surface, streaked and flecked with dark beds of sea-weed, which contrast strongly with the lights reflected from its clean white bottom.

Having no diving-bell or boat of the Jules Vernian type at our command, we will enter the sea garden in true native fashion with water-glass and sponge-hook, with a light suit, and above all with a shoe which is proof against the venomous darts of the black sea urchin.

With the water-glass in hand you are equipped for the voyage. With this clear eye you can read the secrets of the sea bottom at any depth you please—2, 10, 20 fathoms. The crystal water is like a lens, and the sandy bottom like a white screen, which reflects and diffuses a soft light through the ocean depths. We behold a tropical forest in miniature as in a Claude Lorraine glass, in richness of color, in variety of form and in wealth of animal and plant life far surpassing anything that the shores produce. The quivering fans and gay plumes of gorgonia, the delicate sprays and wide branching arms of living corals, are the trees of this submarine garden, while sea anemones and algæ of many hues are the flowers and sward. Here and there are large mush-room-like masses of the brain coral. Sheltered beneath the coral boughs lie innumerable sea urchins, bristling all over with black, shiny needles. Splendid fishes dart in and out among the tremul-ous fans, while a myriad of smaller animals dwell unseen at the bottom of the reef.

Studying more closely the revelations of the water-glass, we see that the prevailing colors are shades of brown with bold touches of purple, red, yellow and green, not to speak of the resplendent hues of the many forms of animal life which make their home on

the reef, the mere naming of which would read like the inventory of a museum.

The sea fans (*Gorgonia flabellum*) are not to be mistaken. They stand erect, firmly anchored to the stony floor, and are forever repeating the slow undulating movements of the water. Their lace-like texture distinguishes them at once from the related "sea-feathers" (*Pterogorgia*), whose graceful nodding plumes, sometimes six feet tall, are the branching foliage trees of the coral garden.

Fish swim amid the waving fans, and thread the maze of the coral caves, as much at home as the birds in the neighboring bush, and far surpass the latter in the brilliancy of their colors. It is a memorable though common sight to meet a school of fish moving leisurely over the reef. Through the softened light and clear perspective of the water you see a hundred shining forms pass slowly across the painted screen, amid lilac fans and coral-sculptured rocks. Some are armored with a coat of burnished cerulean scales, or banded with black and blue, or, like the grotesque trunk-fish (*Ostracion*), dappled with a variety of tints. A blue fish (not the market fish, but a very different and very much bluer species, from whose iridescent, cobalt scales, the natives of New Providence make pretty ornaments) may be seen lazily swimming over a sand-bottom, which they frequently probe with their blunt noses, their bright coats gleaming with every lash of the tail and movement of the body.

The *turbot*, as he passes, ogles you with his large, glassy eye, or pokes his inquisitive nose into a sponge, — an odd fish from every point of view. He is about as broad as long, and has an ugly looking mouth with projecting teeth, and a deeply forked tail, the ends of which are drawn out into long streamers. The dorsal fin is peculiar, and has given rise to its nickname, the "trigger-fish." By a simple anatomical arrangement, the foremost spine of this fin, which is a sharp, dagger-like weapon, when once erect cannot be pressed down, but touch the smaller spine next to it, and down it falls like the trigger to a gun.

Perhaps one of the most striking fish we meet on a coral reef, although it is hard to decide which is the most striking, is the "hog fish," as it is called by fishermen on account of the grunt-

ing sound it makes when taken from the water. Its general shape is that of a sun fish or bream. It is jet black, excepting the head and tail, which look as if they had been dipped in a golden-yellow dye.

The brain corals (*Diploria cerebriformis*) already referred to, whose rounded surfaces are stamped with those peculiar, intricate patterns, take a high rank among reef-building polyps. They form masses from a few inches to several feet in diameter, or cover the bottom with large convoluted plates (*Meandrina.*) These help largely in building up the "coral-heads," the highest points on a growing reef, where the word is synonymous with *dangerous rocks.* A dozen different species may contribute to the growth of the head. Sponges and gorgonias attach themselves. You may see the bright rosette of a sea-anemone fastened to a stone, or detect the long "feelers" of the spiny lobster projecting from some niche in the wall. Boring sea-urchins, mollusks and barnacles perforate the living stones and thus assist the destructive action of the waves. This explains the detached fragments of coral which we see strewn everywhere over a reef. They fall an easy pray to the waves, and are slowly pounded into fine coral sand like that of the beach. This beach-sand is then endlessly rocked and shifted about, mixed with pieces of coral, conch shells, and with the bones or stony remains of countless marine organisms which inhabit the neighboring sea, until the whole is sometimes cemented into compact sand-stone, the ultimate building material of reef or island. By thus continually extracting matter from the sea water, and yielding it up in the form of solid particles of carbonate of lime, the insignificant polyp contributes to the growth of continents.

The delicate madrepores (*Madrepora arbuscula*) resemble deer's antlers or the forms of some branching shrubs, which the least blow shivers in pieces. In the water they have a light lavender hue, but bleach to snowy whiteness in the sun. The "propeller coral," as it is called by the natives, resembles clusters of brown leaves. In some places the bottom is fairly peppered with small coralline masses, the size of paper weights, their surface deeply indented with vermiform characters, well named "*chenille-stones*"

(*Manicæna areolata.*) In the "lancet coral" the partitions or thin plates lining the folds are beset with sharp cutting teeth.

The floor of a coral reef is a mosaic of living stones. The prevailing hues are browns, yellows and greens, which are relieved, as we have seen, by touches of bright colors. As the back ground of a forest enhances by the contrast the bright liveries of the birds and insects and the painted petals of flowers, so the sombre coral masses are illumined by purple alcyonaria, by scarlet actinia, by the vermilion heads of worms, and by the varied colors of the throng of animal and plant life.

On the land as in the sea the greatest harmony of colours seems to prevail among those forms which are capable of the least motion, like the stationary trees and the solid coral-stocks, while the restless fish, the crabs and worms which crawl at will over the bottom or thrust their heads from their burrows, the sea-anemones which, however incapable of active locomotion, can so retract their bright bodies that only an obscure disc is seen, may all wear the richest and most varied hues.

The meaning of colors in the organic world, if they have a meaning, is a subject of great interest, and it is commonly believed that the color of many animals has been acquired by natural selection, and has a protective significance, which is probably true. It has been discovered that certain insects are protected by the extraordinary and forbidding brilliancy of their colors, and by assuming the colors of common poisonous species, thus sharing the latter's immunity from harm. But many phenomena which we constantly meet with are not to be thus explained. A case in point of much interest is that of the West Indian shore crab (*Gregarinus ruricola*). This beautiful crab burrows in the mangrove swamps at about the level of high water, and is common throughout the Bahamas. I happened to land at the eastern extremity of Hog Key one day in April, just after heavy rains had flooded the island and routed the shore crabs from their dwellings. Nearly every green spray and bough was ornamented with these handsome crabs, which were decorated in the brightest and most varied hues. Some of them have the legs crimson and the body a dark purple, with a large yellow

spot like an eye on each side of the back. In others these tints are reversed, the spots being purple on a light ground. Others again are nearly black, or the carapace is orange or straw color flecked or marbled with purple, or the body is purple tinged with orange, in an endless series of patterns so that no two are alike. These fickle colors seem to be all for show. They plainly have no protective meaning, but are due to some subtile physiological cause of which we are ignorant.

A negro was living near this spot above a little stretch of white beach, and under the shade of a beautiful grove of cocoanut palms. About his cabin were strewn the telling remains of many crab dinners. He told me that these animals "begin to crawl" after rain at about 8 o'clock in the morning, and disappear again about 4 in the afternoon. Their legs are fringed with sharp spines or climbers, by the aid of which they readily ascend trees, and the large pincers which they brandish, not without effect, show plainly that they are able to protect themselves.

The crabs have many queer habits. An odd freak is that of tucking little stones in their ears after moulting the skin, but what is more surprising is the apparent indifference and address with which they will sometimes amputate their own limbs. I saw a good piece of this invertebrate surgery one day when I captured a shore crab which was crossing the road. A crab always cuts a comical figure as it runs sidewise, eying you with its optic organs raised aloft like a pair of opera glasses. As Charles Kingsley says of the four-eyed fish, he who sees a crab scuttling across the road for the first time without laughing must be much wiser or much stupider than any man has a right to be. I had pinioned this crab with my foot, and held him as I supposed securely by the "great pincers," one in each hand, when he suddenly dropped both claws, and scuttled off with apparent unconcern, although he had parted with his most valuable weapons. [1]

[1] This is a genuine amputation, and is not due merely to accident or to the fragility of the legs. Experiment has proved that it is caused by a vigorous muscular contraction, and that it is a reflex act. The limb of a dead crab, or of one in which the nervous system has been paralyzed, will lift a weight of several pounds. Any profound nervous shock like that given by rapidly cuttting off part of a leg with sharp scissors, or by electrical or chemical stimuli, produces the same result.

The comparison of a coral reef to a garden of plants or of the branching coral to a tree has a significance which it is interesting to notice. The tree and coral agree in being plant and animal communities, leading a composite or corporate life of mutual benefit. That the tree is a community is seen by its reproducing by buds, by cuttings and roots, as in the case of the Banyan or Pagoda Fig Tree of India, where a whole forest may arise from a single seed. The life of the tree is moreover near the surface, in the sap wood, while the heart is practically dead and useless, except for support.

So the coral starts as a simple egg or cell, and by the asexual process of budding builds up a community. The coral stock is alive only at the surface, the superficial polyps resting on the dead skeletons of previous years, as the living wood rests upon the rings of old growth. This comparison fails completely with the feeding of these communities, since the tree takes its food not only by the leaves but by its new roots, while a coral has no living roots, but gets all its nourishment from the water through the mouths of the individual polyps,

An abraded skin and lacerated fingers await the diver on a coral reef, for its wonders cannot be explored without cost. The indescribable glimmer which pervades the transparent waters, subdues and blends all distant objects, and plays in a green light at the surface. This is the veil which the sea nymphs hold before the eyes of the visitor to their realms.

A light cream-colored species related to the fan-corals are the "nettles" of the reef, which one is sure to meet on his first visit thither, and equally sure to avoid on his next. They encrust stones or corals of other species, and, being amply provided with poison cells, are like fire to the touch. Most of the common corals and sponges are found at ebbtide in from one half to two fathoms of water or even at less depths. They die quickly when exposed to the sun, and if transferred to the sea again they become skeletons in a few hours.

The black sea urchin (*Diadema*) to which allusion has been made, is the bug-bear of the reefs, and every experienced person gives it a wide birth. The white sand is sometimes blackened

by them. The body of the animal, though small, is stuck so full of long black needles that it makes a bristling ball more than a foot in diameter. Each spine is a poisoned dart, and as brittle as glass. At some points on a reef you can hardly turn a stone without encountering this black monster. The Bahaman diver and sponge fisherman know them well. I have heard them tell of several unfortunate men who received a full dose of this animal's poison. As to the pain and cramp which comes from a pin prick in the finger administered by this urchin, I can answer by frequent experience, and can readily imagine the exquisite torture, bordering on madness, which is said to result from closer acquaintance.

If we leave the reef and wander along the shallows of the bay, we see plainly written on its sands evidence of a different though by no means scanty population. Here, for instance, I see the sand-floor dotted with conical elevations like volcanoes on a raised map, with open craters at their tops, or it is there perforated with small holes. Resting on many of the latter I see spherical masses of a transparent jelly, looking as if it had been thrown out by an eruption from below, while long strings of this tremulous substance are protruding from others. These are the submarine dwellings of *annelids*—sea worms, which burrow deeply in the sand, and lay their tiny eggs, much after the manner of frogs, in large masses of jelly, which serve both for food and protection to the young. The number of the marine worms is well nigh countless. They roll out of nearly every sponge or rock which is brought up from the reef. Many are painted in the most delicate and exquisite colors, and suggest nothing that is repulsive. Some species build elastic tubes, a cluster of which is like a bunch of flowers. Each tube, the size of a pencil perhaps (when its tenant is undisturbed), is crowned with a circular fringe of brown or scarlet feathers. Stoop to pick the flower, and presto!—in a wink the worm has drawn in its feathery gills and shut the door, which does not open again for some time to come.

This sand is also dotted with groves and forests of palm-like algæ, whose slender stems, tufted with green, bear every resemblance to toy trees.

There are at least three star-fishes found in this bay, the largest of which (*Pentaceros reticulatus*), the star of the *new* "Curiosity Shop," is of the first magnitude, a foot or more in diameter. It is anywhere a conspicuous object, and its deep brown and yellow patterns show distinctly on the white sea floor. A five-pointed star is the rule, but occasionally a monster appears among them, who abbreviates the number of its arms to 4 or increases them to 6. I once found a small star with only three rays, and one day met with a large fellow, one of whose five normal arms had been amputated, bitten off by an enemy perhaps, and a new one was growing in its stead.

The beds of weed which extend as wide bands up and down the bay are occupied almost exclusively by a large white sea-urchin (perhaps *Hippomœ*), called the "Sea Eggs" from their white papery shells, which are often picked up on the beach. So thick are they it takes some care to avoid stepping on them, to do which with bare feet, to say the least, is certainly not pleasant, although the spines of this species are quite short and without venom. I am reminded of a pasture where the grass is cropped close. Here are forty thousand feeding like one, but not on the grass, for the cropping in this case is not from the herd. The sea weed or alga in question has a narrow blade a few inches long, which ends abruptly as if cut off by scissors. These sea eggs are all of about the same size—that of a flattened base ball, and the question at once arises, Where are the young and intermediate stages? I remember to have seen but one or two undersized sea urchins, although I made daily visits to the reef for many weeks. This is probably but a common illustration of the fact that the struggle for life is far greater with the young than with the adults. Of the newly-born host, a very large number must be overtaken by death before reaching the adult state. But the survivors live through many generations, and thus their numbers increase. If this were not so in the case even of a single prolific animal, the ocean would soon be overrun by it.

The flowers of the coral gardens are the sea-anemones or actinias. They look like bright rosettes, scattered here and there

for ornaments, now pinned to a coral tree or wall-side or half concealed in the grass.

The actinian is in fact a greatly enlarged coral polyp, but without a skeleton, and in consequence of this they can retreat so completely within themselves as to become almost invisible. Place one of these contracted discs in an aquarium of sea water, and a beautiful "flower" will soon unfold, to your astonishment, filling the whole jar. When this animal multiplies by budding or by division a new individual is formed like the first, and the two separate, so that the colonial stage is never realized. A common and large species (*Cereactis*) has a vermilion body, and drab, carmine-tipped tentacles. I once saw a patch of white sand bordered like a parterre by a row of these bright flowers on either side.

To one who has not given the subject a thought, it may take some stretch of imagination to associate the corals with the popular idea of animal life, but as we see the living mass, and the individual polyps, opening their mouths and extending their fringes of waving tentacles, any doubt in the matter will probably be removed. The coral stock or the sea fan is in fact a colony of animals, as truly as a hive of bees or an ants' nest is, but the former is composed of individuals united by a peculiar method of growth, while in the latter case the indiviruals are separate and specialized for different labors.

The coral polyp, which, in spite of the protests of naturalists, is commonly called an *insect*, by the popular error of including under this term most small and insignificant beings, is in fact further from the insect than the insect is from man. It starts life as a free swimming oval body, which hatches from an egg smaller than a pin's head. This active embryo acquires a mouth at one end, and is now significantly called a *gastrula* or stomach animal. It soon attaches itself by the opposite end to some rocky support, and thenceforward is a prisoner. This young polyp now develops tentacles or feelers about its mouth, and begins the deposit of lime which is to make its skeleton. This takes the form of a cup in which the animal rests, it being always external to its own skeleton. Thin partitions or septa grow inward from the

sides of this cup. They correspond to the tentacles, and with the latter increase in number with the age of the polyp according to definite laws. The animal then begins to reproduce asexually by division and budding, and the method and degree of completeness with which this is carried out, determine the form of the coral stock. The fragile madrepores branch in the most intricate manner, while other forms are massive, the cups of individual polyps being closely crowded and united in a common base. In the brain corals the sides of the neighboring cups unite to form intricately winding valleys.

The fan corals or alcyonaria (named for Alcyone, the daughter of Neptune) have invariably eight tentacles, and usually a horny instead of a calcareous skeleton. Under this head falls the *Corallium rubrum* of the Mediterranean, which yields the red coral stone of jewelry, but it is exceptional as regards its hard skeleton.

It quite as true of the corals as of the flowers of the field, "they toil not neither do they spin," and any metaphor of the poet which implies 'labor' or 'skill' in the polyp community such as we see in the construction of the honey-comb by the bees is rightly objected to as being misleading, since it is false to nature. The white and porous limestone structure which we call "coral," or technically a *corallum*, is in fact the inorganic frameworks of the polyp colony, and it costs the coral animals just as much labor as it does us to make the bones in our bodies.

Reef-building corals occupy a zone about 28° on either side of the equator and in both palæozoic and recent times they have produced important changes on the earth's surface, building up islands in the sea and adding to the coasts of continents. They do not flourish below a depth of 15—20 fathoms, and are absent from the mouths of rivers, since they require the pure sea water.

Once let the waves throw up a sand bar on the reef, and a new island is therewith born. A thousand and one objects attach themselves, and the constructive processes get the upper hand. The mangrove tree is an early visitor, and its peculiar methods of growth fit it admirably as a pioneer in the vegetation of the new island. The seeds of this plant develop in the calyx, before they fall from the tree, each sending out a curved cylindrical stalk

(radicle or caulicle) several inches long. These float like corks on the water, and the little plant, which now resembles a cigar loaded at one end, is ready to strike root wherever it touches soil. The young tree grows apace, and further shows that it has come to stay by sending down roots from the branches, which serve as little guy ropes to anchor it firmly in the sand, This new land is in a state of constant ebb and flow, until its sand bars and dunes have been firmly cemented into coral limestone. The sea and the rain eat away the soft rock, carving it into fantastic forms. A soil however will gradually accumulate in little pockets at the surface, where the seeds of plants brought thither by birds, by wind or wave, immediately germinate, and cover the already old yet new island with a mantle of green.

The whole subject of the formation of coral islands is now being vigorously discussed.

Before Darwin's day it was generally believed that coral islands were incrustations on the top of lofty sub-marine mountains. But when, 50 years ago, Darwin made his celebrated "Beagle" voyage (1832-1836), and afterwards published his account (second only in fame to his later theory of the origin of species), of the origin of these wonder-islands in mid-ocean, the older view was at once discarded. The key to his explanation was subsidence, the sinking of the ocean bottom. What were once table lands and mountains rising out of the Pacific and Indian Oceans, are now only sunken peaks crowned with coral limestone. The coral animals themselves impose, as we have seen, peculiar conditions. They require pure and warm sea-water and a bountiful supply of oxygen, and die if subjected to cold currents, to sediments, and if carried to a greater depth than 100 to 120 feet. With these conditions the problem seems simple enough. The land, a volcano we will say, is very slowly sinking in a tropical sea. The coral polyps will attach themselves to its shores, will grow within the zone of their bathymetrical life limits, and will gradually build up a fringing reef. As the mountain sinks this reef grows out from the land, since the outer corals exposed to the wash of the waves from the open sea, are in a better environment than those next the shore, and hence grow the fastest.

Then if the mountain sinks out of sight, the same processes continuing *pari passu*, the atol is produced, the last link in the chain of development. We begin with the fringing reef; we end with the atol, a ring of coral, with a central lagoon just over the mountain top. This is a brief and partial statement of the theory, which Dana substantially corroborates.

But in recent years much new light has been shed upon this fascinating subject, and it now appears as if Darwin's theory of coral reefs and islands, simple and plausible as it is, is destined to be set aside. It can be certainly said that it is not of general application. Agassiz found evidence of elevation in the Florida reefs, and later Murray, of the Challenger Expedition, has given an entirely new explanation of the Pacific coral reef and atol. This expedition, sent out to explore the deep seas, was equipped with all the appliances which modern science could command, and the importance of its results to the scientific world can hardly be overestimated. According to this observer, the principal factors in the formation of coral structures are the elevation in the deep sea of suitable platforms in which corals may build, either by volcanic action or by the deposit of organic sediments; the abrasion and solution of the coral rock itself. Of the subsidence which Darwin's view requires, there is no certain proof, while on the contrary in the Pacific and Indian oceans there has been in many cases an elevation of land. No trace of a sunken mountain peak as the base of a coral island has ever been discovered. The outer wall next the sea is usually not precipitous except for the first few fathoms. It then slopes off gradually to great depths. Oceanic islands are usually volcanic, and in moderately shallow waters there is a constant rain of minute solid particles to the bottom. These consist of siliceous and calcareous shells of the minute organisms with which the surface waters of the tropical seas are teeming. Having then a suitable base on which the corals may build, then the greater growth of the margin of the reef, and the erosion of the dead inner parts, will account for all the phenomena. As already said the coral island is formed by the accumulation of its own débris.

The ocean and especially the tropical ocean is, as it has always been, the great home of life. The forces which in cooler climates tend to repress and retard animal and plant life, here favor and force it onward. The battle for existence is here most incessant, its phenomena most marked. There results that boundless range of form and color, that exhaustless spring of individual life, which may well excite our wonder and our love.

THE ETIOLOGICAL CLASSIFICATION OF DISEASES.

BY FRANK S. BILLINGS.

BEFORE discussing this part of nosology it may be well to say a few words on the classification of diseases in general. First, we differentiate them according to that tissue of an organ in which the initial stage of the disease occurs, or in which the lesions predominate, or in other words, as to whether the active, or the stromatous, or supporting tissues are first complicated; that is, into interstitial or parenchymatous. It is well that this point be completely understood.

Those who are engaged in giving instruction in our medical schools, as well as those members of the profession who have an especial fondness for pathology, generally find that not only the students per se, but a great many practicing physicians, either have, or obtain, the idea that the above classification is something absolute, and that the processes are entirely limited to the tissues indicated in the differentiation. This is an error, but it seems to be a necessary failing of the text books to keep up this sharp differentiation, which would not be so serious had the authors but called attention to the fact that, while the pathological processes may begin in one kind of tissue, for instance the parenchymatous, if severe and prolonged in action they must eventually com-